EP 23575 (5)

A7

P01 CAL021 EP

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 164 345 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
19.12.2001 Bulletin 2001/51

(21) Application number: 00981693.5

(22) Date of filing: 13.12.2000

(51) Int Cl.[7]: F28F 1/30, F28F 9/26

(86) International application number:
PCT/JP00/08827

(87) International publication number:
WO 01/44741 (21.06.2001 Gazette 2001/25)

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority: 14.12.1999 JP 35481999

(71) Applicant: Denso Corporation
Kariya-city, Aichi-pref., 448-8661 (JP)

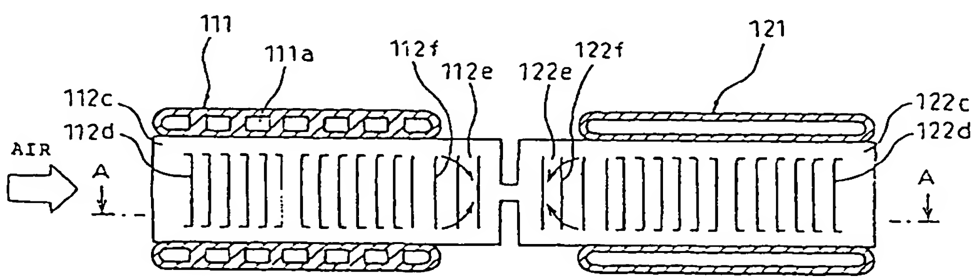
(72) Inventors:
- OZAKI, Tatsuo
Kariya-shi Aichi 448-8661 (JP)
- MUTO, Satomi
Kariya-shi Aichi 448-8661 (JP)
- SAKANE, Takaaki
Kariya-shi Aichi 448-8661 (JP)

(74) Representative:
Klingseisen, Franz, Dipl.-Ing. et al
Patentanwälte, Dr. F. Zumstein, Dipl.-Ing. F. Klingseisen, Postfach 10 15 61
80089 München (DE)

(54) HEAT EXCHANGER

(57) Waved uneven portions (112f, 122f) are formed on the protrusion portions (112e, 122e) of the fins (112, 122) protruded from an end of the tubes (111, 121) in the width direction of the tube without cutting part of the protrusion portions (112e, 122e) to increase the surface area of the fins (112, 122). AS a result, the surface area of the protrusion portions (112e, 122e) may be increased without decreasing the thermal conductive area extending to the end of the protrusion portions (112e, 122e), and thereby a sufficient amount of heat may be conducted especially to the protrusion portions (112e, 122e), with decreasing airflow resistance, and an improvement in radiation ability appropriate to the increase of radiation area may, accordingly, be achieved.

Fig.4A



EP 1 164 345 A1

Description

Field of the Invention

[0001] The present invention relates to a heat exchanger, particularly to a duplex heat exchanger in which a radiator and a condenser for a vehicle are integrated.

Background of the Invention

[0002] According to the invention proposed in Japanese unexamined Patent Publication 10-231724, for example, the cooling fins of the heat exchanger have a protrusion portion protruded from an end of the tube in the width direction of the tube to the direction perpendicular to the longitudinal direction of the tubes to increase the radiation area, thus improving the radiation ability of the heat exchanger. The width direction of the tube is a direction perpendicular to the longitudinal direction of the tube.

[0003] As is well known, the louvers on the cooling fin (called a fin hereinafter) are formed in louver board style by cutting and setting up part of the fin, and disturb the airflow around the fin to suppress growth of the temperature boundary layer, thereby improving the heat transfer coefficient between the airflow and the fin. However, since the louvers disturb the airflow, the resistance to the airflow passing through the heat exchanger may be increased.

[0004] In addition, since the louver is formed by cutting and setting up part of the fin, the thermal conductive area of the fin extending to the end of the protrusion portion is decreased, and thereby a sufficient amount of heat may not be conducted from the tube to the fin, and the improvement in radiation ability appropriate to the increase in radiation area may, accordingly, not be achieved.

Disclosure of the Invention

[0005] It is therefore an object of the invention to improve the heat exchanging ability of a heat exchanger having fins protruded from an end of the tube in the width direction thereof.

[0006] In order to achieve the above object, a heat exchanger according to the present invention comprises a plurality of tubes (111, 121) in which fluid flows and which extend to the direction perpendicular to the direction of airflow, and fins (112, 122) which are provided on the outer surface of the tubes (111, 121) to accelerate the heat exchange between air and the fluid, wherein the fins (112, 122) have protrusion portions (112e, 122e) protruded from an end of the tubes (111, 121) in the width direction of the tube to the direction perpendicular to the longitudinal direction of the tubes (111, 121), and uneven portions (112f, 122f) are formed on the protrusion portions (112e, 122e), without cutting part of them, to increase the surface area of the fins (112, 122).

[0007] In this embodiment, the surface area of the protrusion portions (112e, 122e) may be increased without decreasing the thermal conductive area extending to the end of the protrusion portions (112e, 122e), and thereby a sufficient amount of heat may be conducted from the tubes (111, 121) to the fins (112, 122), especially to the protrusion portions (112e, 122e), and the improvement of radiation ability appropriate to the increase of radiation area may be achieved accordingly.

[0008] In addition, the uneven portions (112f, 122f) do not disturb the airflow as much as the louvers because the uneven portions are not formed by cutting part of the fins in contrast to the louvers, thus decreasing the airflow resistance more than the louver. Although the heat transfer coefficient of the protrusion portions (112e, 122e) may be lower than that in case that the louvers are provided, the surface area of the protrusion portions (112e, 122e) are increased without decreasing the thermal conductive area of the protrusion portions (112e, 122e), and the air volume is increased due to the decrease of airflow resistance, and thereby the radiation ability may be improved,

[0009] Another embodiment of the present invention comprises a plurality of tubes (111, 121) in which fluid flows and which extend to the direction perpendicular to the direction of airflow, and fins (112, 122) which are provided on the outer surface of the tubes (111, 121) to accelerate the heat exchange between air and the fluid, and on which louvers (112d, 122d) are formed in louver board style by cutting and setting up part of the fins (112, 122), wherein the fins (112, 122) have protrusion portions (112e, 122e) protruded from an end of the tubes (111, 121) in the width direction of the tube to the direction perpendicular to the longitudinal direction of the tubes (111, 121), and the louvers (112d, 122d) formed on the protrusion portions (112e, 122e) are different from the louvers (112d, 122d) formed on the other portions than the protrusion portions (112e, 122e) of the fins (112, 122).

[0010] In this embodiment, the airflow resistance of the protrusion portions may be decreased, and the improvement in radiation ability appropriate to the increase of radiation area may be achieved accordingly.

[0011] The heat exchanger of another embodiment of the present invention is a duplex heat exchanger comprising a first heat exchanger (110) which is a heat exchanger according to the present invention, and a second heat exchanger (120) which is a heat exchanger according to the present invention arranged in series with the first heat exchanger (110) in the direction of airflow, wherein the protrusion portions (112e) of the first heat exchanger (110) are protruded to the second heat exchanger (120), and the protrusion portions (122e) of the second heat exchanger (120) are protruded to the first heat exchanger (110).

[0012] The present invention will be more fully understood in conjunction with the accompanying drawings

and the descriptions of the preferred embodiments of the present invention.

Brief Description of the Drawings

[0013] In the drawings:

Fig.1 is a perspective view of the duplex heat exchanger of the first embodiment of the present invention viewed from the upstream side of the airflow.
Fig.2 is a perspective view of the duplex heat exchanger of the first embodiment of the present invention viewed from the downstream side of the airflow,.
Fig.3 is a perspective view of the fin of the duplex heat exchanger of the first embodiment of the present invention.
Fig.4A is a cross-sectional view of the core part of the duplex heat exchanger of the first embodiment of the present invention.
Fig.4B is a cross-sectional view of the core part along the line A-A shown in Fig.4A.
Fig.5 is a perspective view of the core part of the duplex heat exchanger of the first embodiment of the present invention.
Fig.6 is a perspective view of the core part of the duplex heat exchanger of the second embodiment of the present invention.
Fig.7 is a perspective view of the core part of the duplex heat exchanger of the third embodiment of the present invention.
Fig.8 is a perspective view of the core part of the duplex heat exchanger of the fourth embodiment of the present invention.
Fig.9 is a perspective view of the core part of the duplex heat exchanger of the fifth embodiment of the present invention.
Fig.10A is a cross-sectional view of the core part of the duplex heat exchanger of the sixth embodiment of the present invention.
Fig.10B is a cross-sectional view of the core part along the line A-A shown in Fig.10A.
Fig.11A is a cross-sectional of the core part of the duplex heat exchanger of a variation of the present invention.
Fig.11B is a cross-sectional view of the fin shown in Fig.11A.
Fig.11C is a cross-sectional of the core part of the duplex heat exchanger of another variation of the present invention.
Fig.11D is a cross-sectional view of the fin shown in Fig.11C.

Preferred Embodiments of the Present Invention

(The first embodiment)

[0014] The first embodiment relates to a duplex heat exchanger, which is a heat exchanger according to the present invention, in which a condenser (radiator, condenser) for a refrigeration cycle system (air conditioner) for a vehicle, and a radiator for cooling the cooling water (cooling liquid) for a water-cooled engine (liquid-cooled internal combustion engine). Fig.1 is a perspective view of the duplex heat exchanger 100 of the first embodiment viewed from the upstream side of the airflow. Fig. 2 is a perspective view from the water-cooled engine side (downstream side of the airflow). The condenser and the radiator are arranged in series in the direction of airflow so that the condenser is positioned on the upstream side of the radiator.

[0015] In Fig.1, reference numeral 110 denotes a condenser (first heat exchanger) for conducting heat-exchange between the refrigerant circulating in the refrigeration cycle system and air to cool the refrigerant. The condenser 110 comprises a plurality of condenser tubes 111 in which the refrigerant (first fluid) flows, condenser fins (first fins) 112 which are provided on the outer surface between each two condenser tubes 111 to accelerate the heat exchange between the refrigerant and the air, header tanks 113 and 114 which are arranged at the both ends in the longitudinal direction of the condenser tubes 111 and are connected to the condenser tubes 111, etc.

[0016] The header tank 113 at the right side in the figure supplies and distributes the refrigerant to each condenser tube 111, and the header tank 114 at the left side in the figure collects the refrigerant after heat exchanging in each condenser tube 111.

[0017] The condenser tubes 111 are of a multi-hole structure in which many refrigerant paths 111a are formed, and are formed flat in the manner of extrusion work or drawing work, as shown in Fig.4A. The condenser fins 112 are integrated with the after-mentioned radiator fins 122, and the details are discussed later.

[0018] In Fig.2, reference numeral 120 denotes a radiator for conducting heat-exchange between the cooling water flowing out from the water-cooled engine and air to cool the cooling water. The radiator 120 comprises a plurality of radiator tubes 121 in which cooling water (second fluid) flows, radiator fins (second fins) 122 which are provided between each two condenser tubes 111 to accelerate the heat exchange between the cooling water and air, header tanks 123 and 124 which are arranged at the both ends in the longitudinal direction of the radiator tubes 121 and are connected to each radiator tube 121, etc.

[0019] The reference numeral 130 denotes a side-plate which is arranged at the end of the condenser 110 and the radiator 120 to reinforce both of the condenser 110 and the radiator 120. The tubes 111 and 121, the

fins 112 and 122, the header tanks 113, 114, 123, and 124, and the side-plates 130 are integrated by soldering.

[0020] The fins 112, 122 are discussed below.

[0021] The fins 112, 122 are formed in a single piece by a roller forming method as shown in Fig.3, and are wave form corrugated fins consisting of a plurality of crest portions 112a, 122a, trough portions 112b, 122b, and flat portions 112c, 122c which connect adjacent crest portions 112a, 122a, and trough portions 112b, 122b.

[0022] On the flat portions 112c, 122c, the louvers 112d, 122d are formed in louver board style by cutting and setting up part of the flat portions 112c, 122c to disturb the airflow passing through the fins 112, 122 to prevent growth of a temperature boundary layer. As shown in Fig.4A and 4B, connecting portions f are provided at intervals of a plurality of crest portions to connect the fins 112 and 122 so as to keep a distance of more than predetermined length W between the condenser fin 112 and the radiator fin 122.

[0023] The predetermined length W is at least more than the thickness of the fin 112 or 122, and a slit (space) S which is provided by keeping a distance of more than predetermined length W between the condenser fin 112 and the radiator fin 122 functions as a heat transfer suppressing means for suppressing the heat transfer from the radiator 120 side to the condenser 110 side.

[0024] Furthermore, on the radiator tube 121 side of the condenser fin 112, a protrusion portion 112e is provided which protrudes from an end of the condenser tube 111 in the width direction of the tube to the radiator tube 121, in the direction perpendicular to the longitudinal direction of the condenser tube 111. On the condenser tube 111 side of the radiator fin 122, a protrusion portion 122e is provided which protrudes from an end of the radiator tube 121 in the width direction of the tube to the condenser tube 111, in the direction perpendicular to the longitudinal direction of the radiator tube 121.

[0025] In addition, as shown in Fig.5, on the protrusion portions 112e, 122e, uneven portions 112f, 122f are formed in wave form in the manner of plastic deformation by a roller forming machine without cutting part of the protrusion portions 112e, 122e to increase the surface area of the fins 112, 122. The uneven portions 112f, 122f are also formed so that the ridge direction Dw of the uneven portions 112f, 122f is substantially parallel with a cutting direction Dr of the louvers 112d, 122d.

[0026] The ridge direction Dw of the protrusion portions 112f, 122f is the direction ranging the summits of the crest portions 112g, 122g (see Fig.4B) of the wave form uneven portions 112f, 122f, and the cutting direction Dr of the louvers 112d, 122d is the direction substantially perpendicular to the ridge direction Df ranging the summits of the crest portions 112a, 122a of the fins 112, 122.

[0027] Below are described advantages of this embodiment.

[0028] According to this embodiment, the uneven portions 112f, 122f are provided on the protrusion portions 112e, 122e without cutting part of the protrusion portions 112e, 122e, and thereby the surface area of the protrusion portions 112e, 122e may be increased without decreasing the thermal conductive area of the fins extending to the end of the protrusion portions 112e, 122e.

[0029] For this reason, a sufficient amount of heat (arrow marks in Fig.4A) may be conducted from the tubes 111, 121 to the fins 112, 122 (especially to the protrusion portions 112e, 122e), and the improvement in radiation ability appropriate to the increase in radiation area may be achieved accordingly.

[0030] In addition, the uneven portions 112f, 122f do not disturb the airflow as much as the louver 112d, 122d because the uneven portion 112f, 122f are not formed by cutting part of the fins in contrast to the louvers 112d, 122d, thereby decreasing the airflow resistance more than the louvers.

[0031] Although the heat transfer coefficient of the protrusion portions 112e, 122e may be lower than that of the other portions (flat portions 112c, 122c) or the protrusion portion 112e, 122e, on which the louvers 112d, 122d are provided, the surface area of the protrusion portions 112e, 122e is increased without decreasing the thermal conductive area of the protrusion portions 112e, 122e, and the air volume is increased due to the decrease of airflow resistance, and thereby the radiation ability may be improved.

[0032] In addition, since the uneven portions 112f, 122f are also formed so that the ridge direction Dw of the uneven portions 112f, 122f is substantially parallel with a cutting direction Dr of the louvers 112d, 122d, the ridge direction Dw and the cutting direction Dr are both substantially perpendicular to the fin material moving direction of the roller forming machine, and thereby the uneven portions 112f and 122f, and the louvers 112d and 122d may be formed without using a special roller forming machine. For this reason, productivity of the fins 112 and 122 may be improved, and production cost of the fins 112 and 122 (the duplex heat exchanger 100) may be reduced accordingly.

(The second embodiment)

[0033] In the first embodiment, the uneven portions 112f and 122f are formed in a wave form, but in this embodiment, the uneven portions 112f and 122f are formed with dice-formed unevenness (dimples) as shown in Fig. 6.

(The third embodiment)

[0034] In the above embodiments, the uneven portions 112f, 122f are formed on the protrusion portions 112e, 122e without cutting part of the protrusion portions 112e, 122e. But in this embodiment and after-mentioned embodiments, the uneven portions 112f, 122f are not provided, but dimensions of lovers (called protrusion

portion louvers 112d, 122d hereinafter) formed on the protrusion portions 112e, 122e are different from dimensions of louvers (called flat portion louvers 112d, 122d hereinafter) formed on the other portions than the protrusion portion 112e, 122e.

[0035] More specifically, the cutting length L of the protrusion portion louvers 112d, 122d is determined to be decreased with increasing proximity to the protrusion end of the protrusion portions 112e, 122e as shown in Fig.7.

[0036] Thus, the airflow resistance of the protrusion portion louvers 112d, 122d may be reduced, and thereby the improvement in radiation ability appropriate to the increase in radiation area may be achieved.

[0037] Since the temperature difference between the fin and air is generally decreased with increasing proximity to the fin end (the portion farthest from the tube) regardless of the presence or absence of the louver, cooling efficiency of the fin is decreased with increasing proximity to the fin end. Therefore, in this embodiment, the airflow resistance is reduced by decreasing the cutting length L of the protrusion portion louver 112d, 122d at the end of the protrusion portion 112e, 122e where the cooling efficiency is very low.

(The fourth embodiment)

[0038] In this embodiment, cutting length L of the protrusion portion louver 112d, 122d is determined to be increased with increasing proximity to the protrusion end of the protrusion portion 112e, 122e as shown in Fig.8.

[0039] Thus. the airflow resistance of the protrusion portion louver 112d, 122d may be reduced, and the radiation ability may be improved accordingly.

[0040] In addition, the cutting length L at the basal portion side (tube 111, 121 side) of the protrusion portions 112e, 122e having high cooling efficiency is decreased to increase the thermal conductive area, and thereby sufficient amount of heat may be conducted to the basal portion side of the protrusion portions 112e, 122e having high cooling efficiency. For this reason, the improvement in radiation ability appropriate to the increase in radiation area may be surely achieved.

(The fifth embodiment)

[0041] In this embodiment, as shown in Fig.9, in the region on the protrusion portion 112e, 122e, corresponding to the main flow path of the air flowing between tubes 111, 121, i.e. the region which is substantially at the center of the protrusion portion 112c, 122c and is substantially parallel to the airflow, the flat portion 112h, 122h is provided on which protrusion portion louvers 112d. 122d are not formed.

[0042] Thus. the airflow resistance of the region corresponding to the main flow having large flow rate may be reduced, and thereby airflow resistance may be reduced effectively, and the improvement in radiation ability appropriate to the increase in radiation area may be achieved accordingly.

[0043] As shown in Fig.9, the flat portions 112h, 122h are provided so that the cutting length L of the protrusion portion louvers 112d, 122d is increased with increasing proximity to the protrusion end of the protrusion portions 112e, 122e as shown in Fig.9, but the flat portion 112h, 122h may be provided so that the cutting length L of the protrusion portion louvers 112d, 122d is decreased with increasing proximity to the protrusion end of the protrusion portions 112e, 122e.

(The sixth embodiment)

[0044] In this embodiment, the cutting angle β of the protrusion portion louvers 112d, 122d is determined to be decreased with increasing proximity to the protrusion end of the protrusion portions 112e, 122e as shown in Fig.10B.

[0045] The cutting angle β of the protrusion portion louvers 112d, 122d is an angle between the protrusion portion louvers 112d, 122d formed by cutting and setting up part of the flat portions and the flat portions 112c, 122c. $\beta=0$ means that a louver is not formed.

[0046] Thus, the airflow resistance of the protrusion portion louvers 112d, 122d may be reduced, and thereby the improvement in radiation ability appropriate to the increase in radiation area may be achieved.

(Other embodiments)

[0047] The heat exchanger of the aforementioned embodiment is a duplex heat exchanger in which a condenser and a radiator are integrated but the present invention may also provide a single heat exchanger such as a condenser or a radiator.

[0048] For example, Fig.11A~11D show a radiator to which the spirit of the first embodiment of the present invention is implemented. It is apparent from Fig.11C that protrusion portion 122e of the fin 122 may be provided at both side ends of the fin 122.

[0049] As described above, the present invention is described based on the particular embodiments, however, it will be understood by those skilled in the art that the embodiments may be subject to numerous adaptations and modifications without departing from the scope and spirit of the invention.

Claims

1. A heat exchanger comprising a plurality of tubes (111, 121) in which fluid flows and which extend in the direction perpendicular to the direction of airflow, and fins (112. 122) which are provided on the outer surface of the tubes (111, 121) to accelerate the heat exchange between air and the fluid. where-

in the fins (112, 122) have protrusion portions (112e, 122e) protruded from an end of the tubes (111, 121) in the width direction of the tube to the direction perpendicular to the longitudinal direction of the tubes (111, 121), and uneven portions (112f, 122f) are formed on the protrusion portions (112e, 122e) without cutting part of the protrusion portions (112e, 122e) to increase the surface area of the fins (112, 122).

2. The heat exchanger of claim 1, wherein louvers (112d, 122d) are formed in louver board style by cutting and setting up part of the fins (112, 122) on the other portions than the protrusion portions (112e, 122e) of the fins (112, 122).

3. The heat exchanger of claim 2, wherein the uneven portions (112f, 122f) are formed in wave form, and a ridge direction (Dw) ranging over the summits of the crest portions (112g, 122g) of the uneven portions (112f, 122f) is substantially parallel with a cutting direction (Dr) of the louvers 112d, 122d.

4. A heat exchanger comprising a plurality of tubes (111, 121) in which fluid flows and which extend in the direction perpendicular to the direction of airflow, and fins (112, 122) which are provided on the outer surface of the tubes (111, 121) to accelerate the heat exchange between air and the fluid, and on which louvers are formed in louver board style by cutting and setting up part of the fins (112, 122), wherein the fins (112, 122) have protrusion portions (112e, 122e) protruded from an end of the tubes (111, 122) in the width direction of the tube to a direction perpendicular to the longitudinal direction of the tubes (111, 121), and the louvers (112d, 122d) formed on the protrusion portions (112e, 122e) are different from the louvers (112d, 122d) formed on the other portions than the protrusion portions (112e, 122e) of the fins (112, 122).

5. The heat exchanger of claim 4, wherein the cutting length L of the louvers (112d, 122d) formed on the protrusion portions (112e, 122e) is determined to be decreased with increasing proximity to the protrusion end of the protrusion portions (112e, 122e).

6. The heat exchanger of claim 4, wherein the cutting length L of the louvers (112d, 122d) formed on the protrusion portions (112e, 122e) is determined to be increased with increasing proximity to the protrusion end of the protrusion portions (112e, 122e).

7. The heat exchanger of claim 4, wherein flat portions (112h, 122h), on which the louvers (112d, 122d) are not formed, are provided in the region on the protrusion portions (112e, 122e) corresponding to the main flow path of air flowing between tubes (111, 121).

8. The heat exchanger of claim 4, wherein the cutting angle β, of the louvers (112d, 122d) formed on the protrusion portions (112e, 122e), is determined to be decreased with increasing proximity to the protrusion end of the protrusion portions (112e, 122e).

9. A duplex heat exchanger comprising a first heat exchanger (110) which is a heat exchanger of any one of claims 1 to 8, and a second heat exchanger (120) which is a heat exchanger of any one of claims 1 to 8, arranged in series with the first heat exchanger (110) in the direction of airflow, wherein the protrusion portions (112e) of the first heat exchanger (110) are protruded toward the second heat exchanger (120), and the protrusion portions (122e) of the second heat exchanger (120) are protruded toward the first heat exchanger (110).

10. The duplex heat exchanger of claim 9, wherein the fin (112) of the first heat exchanger (110) and the fin (122) of the second heat exchanger (120) are integrated.

11. The duplex heat exchanger of claim 10, wherein a heat transfer suppressing means (S) for suppressing the heat transfer is provided between the fin (112) of the first heat exchanger (110) and the fin (122) of the second heat exchanger (120).

Fig.1

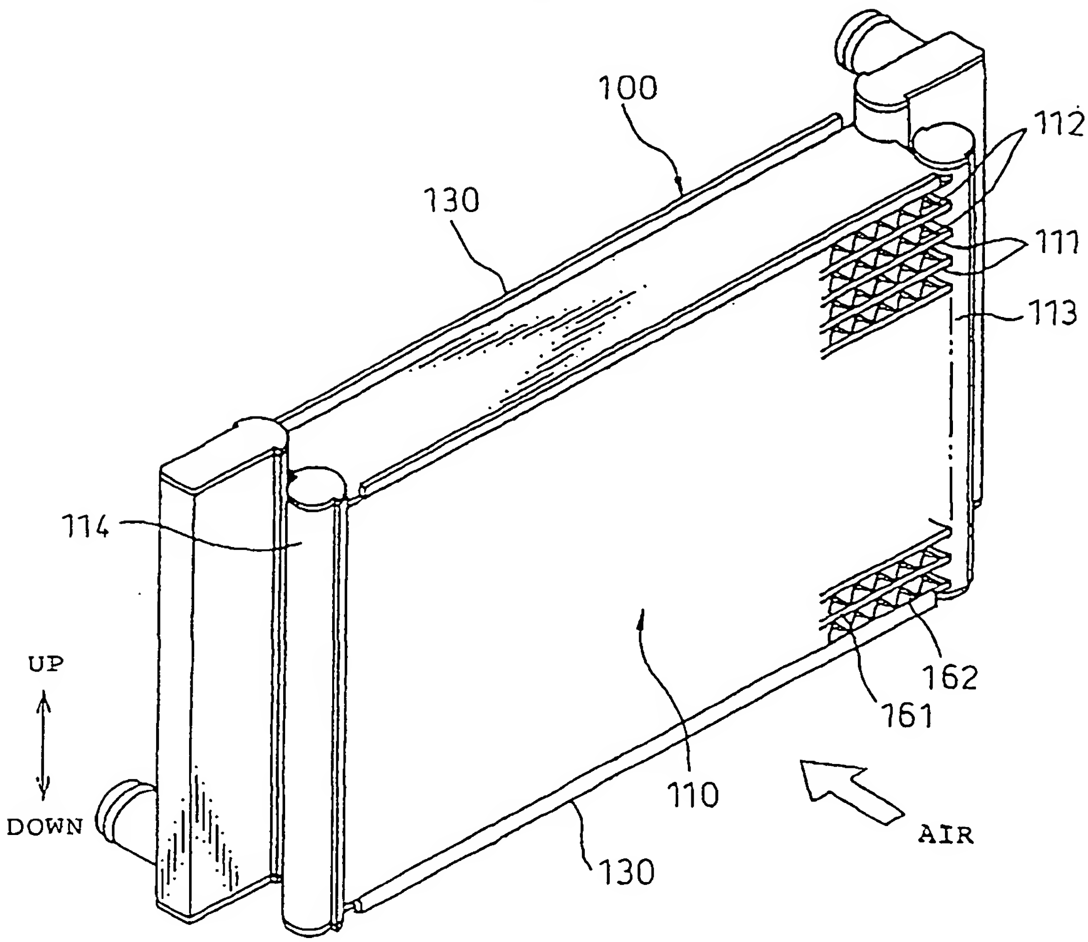


Fig.2

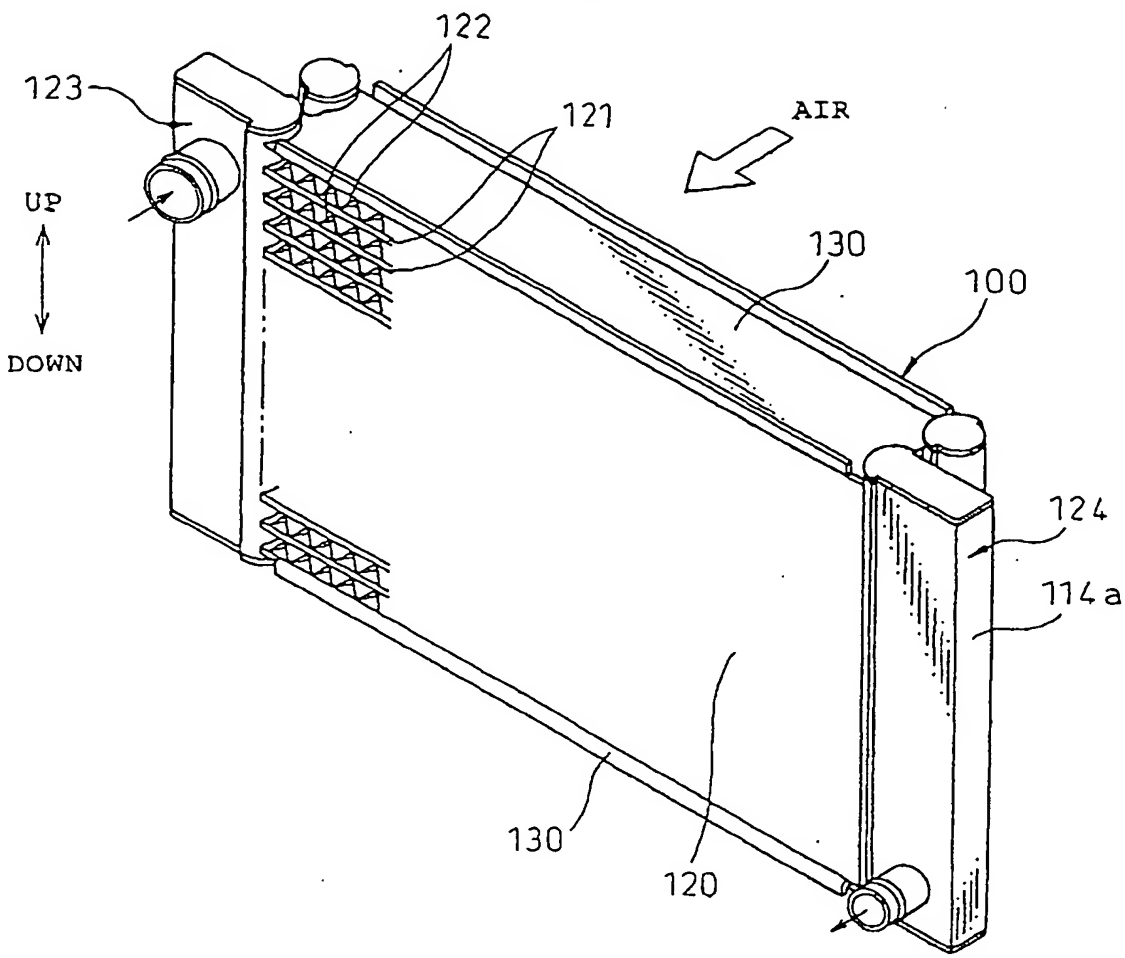
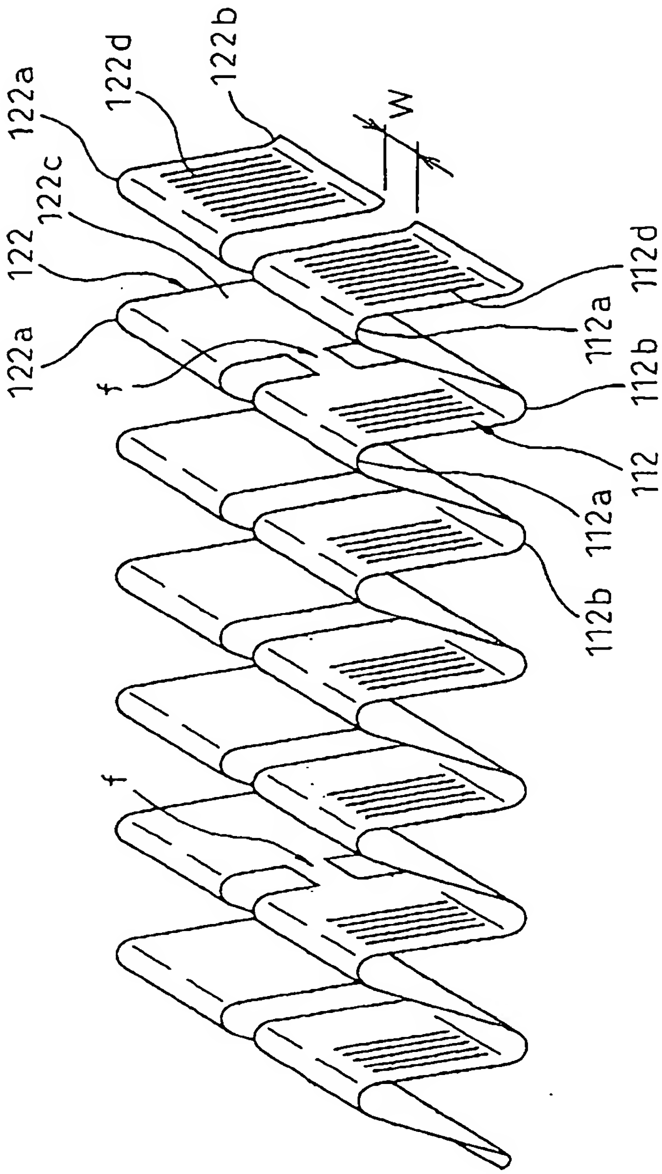
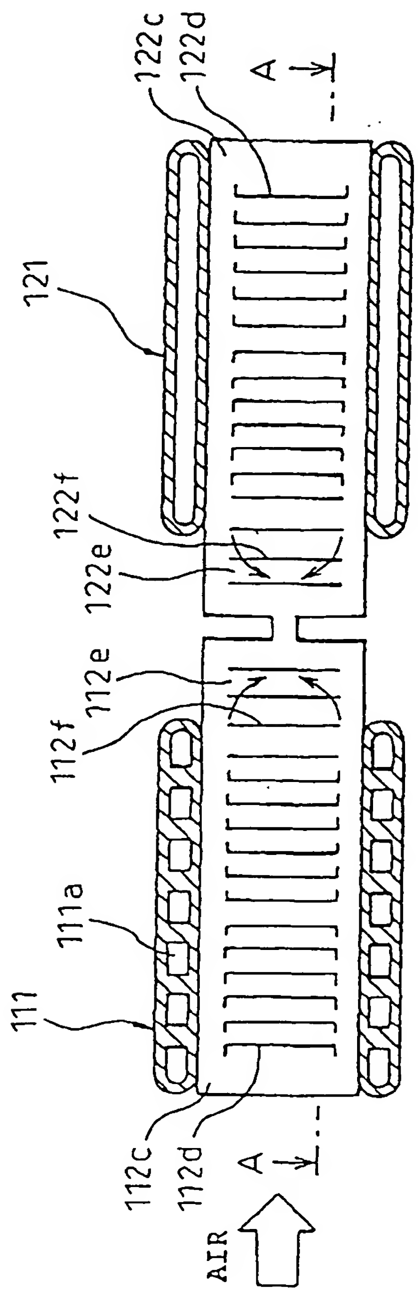


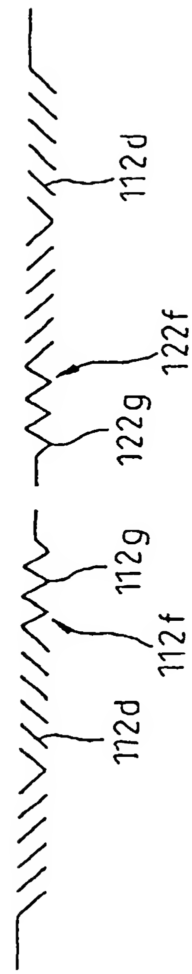
Fig.3





121
122c
122d
A
122f
122e
112e
112f
111a
111
112c
112d
A
AIR

Fig.4A



112d
122f
122g
112g
112f
112d

Fig.4B

Fig.5

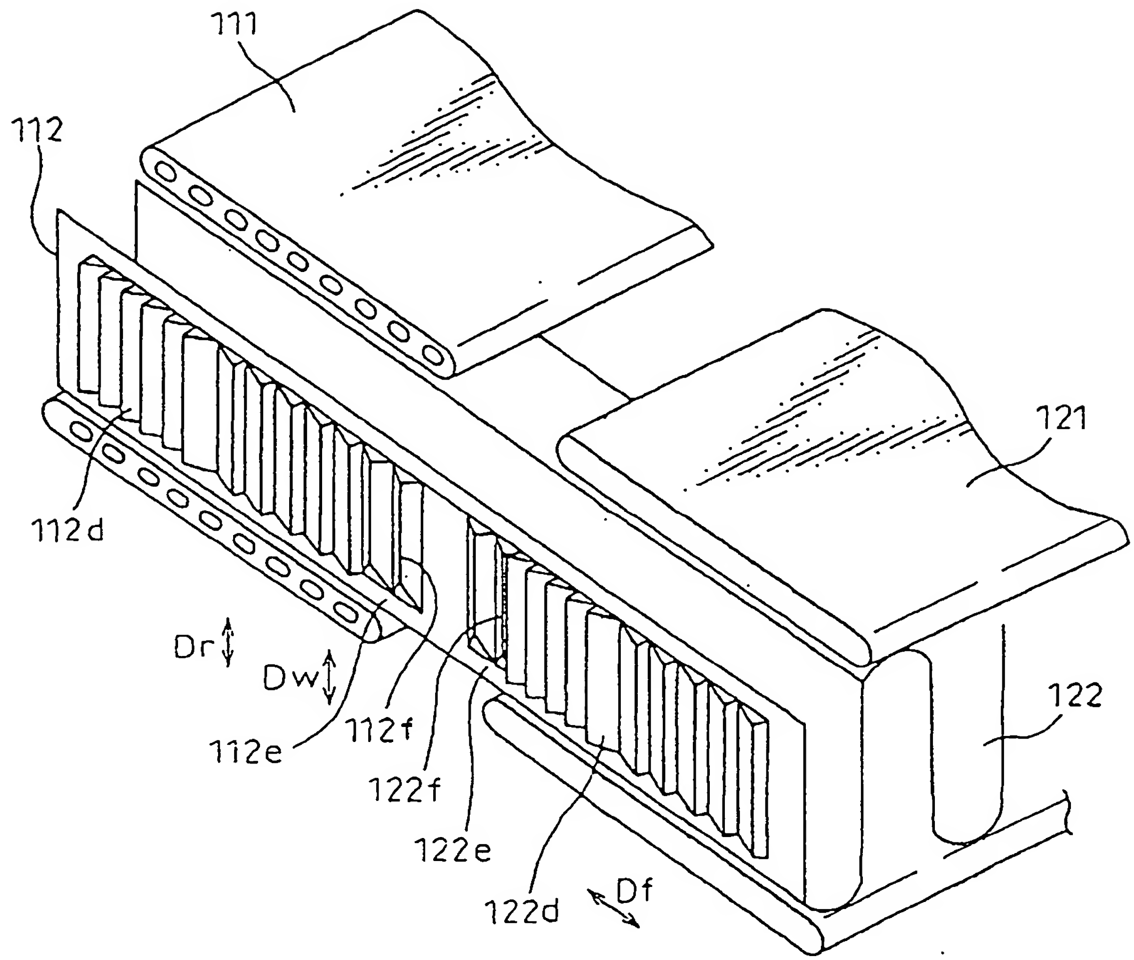


Fig.6

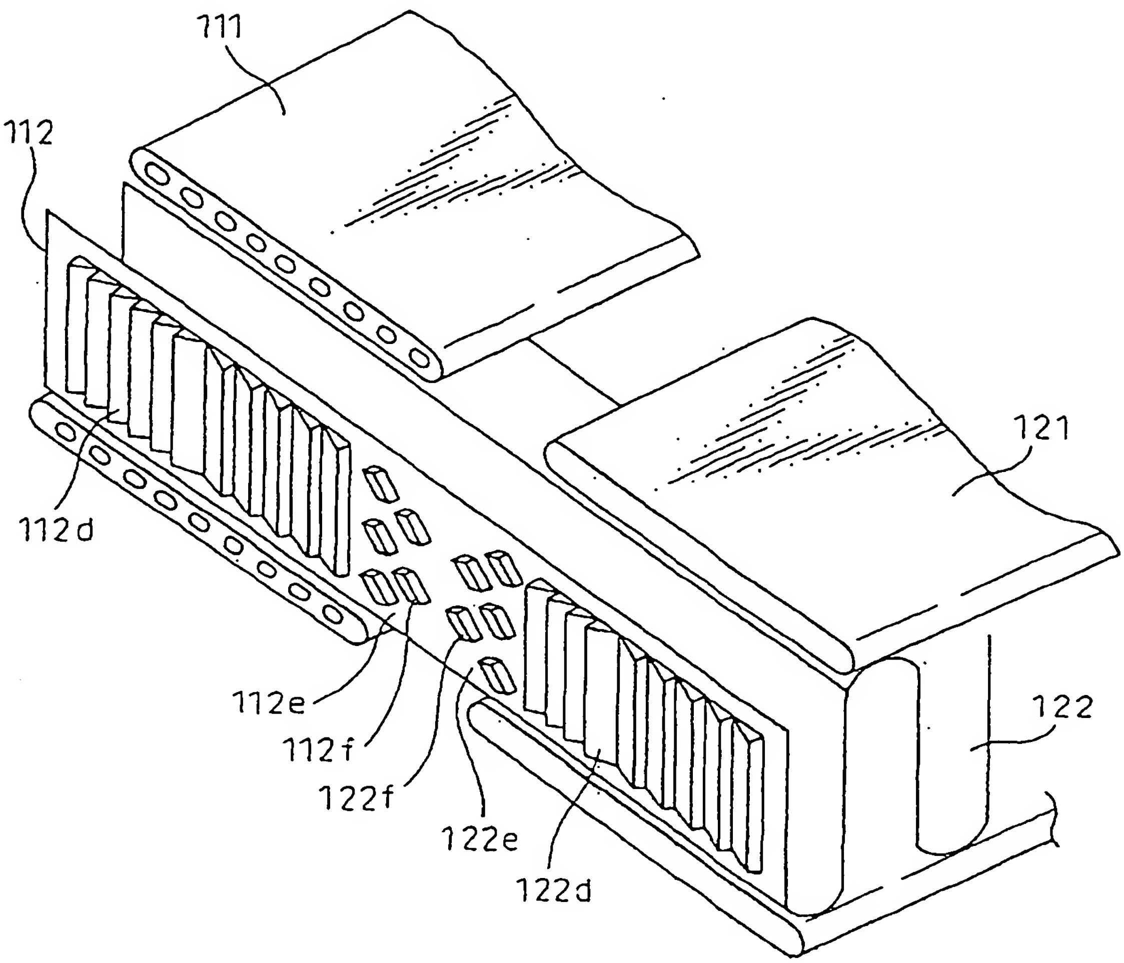


Fig. 7

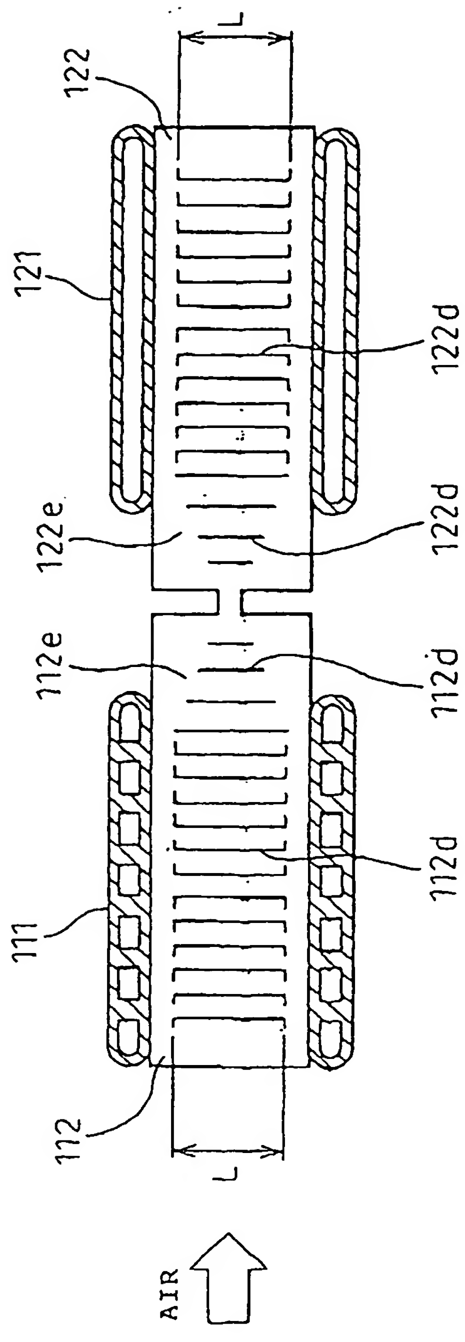


Fig. 8

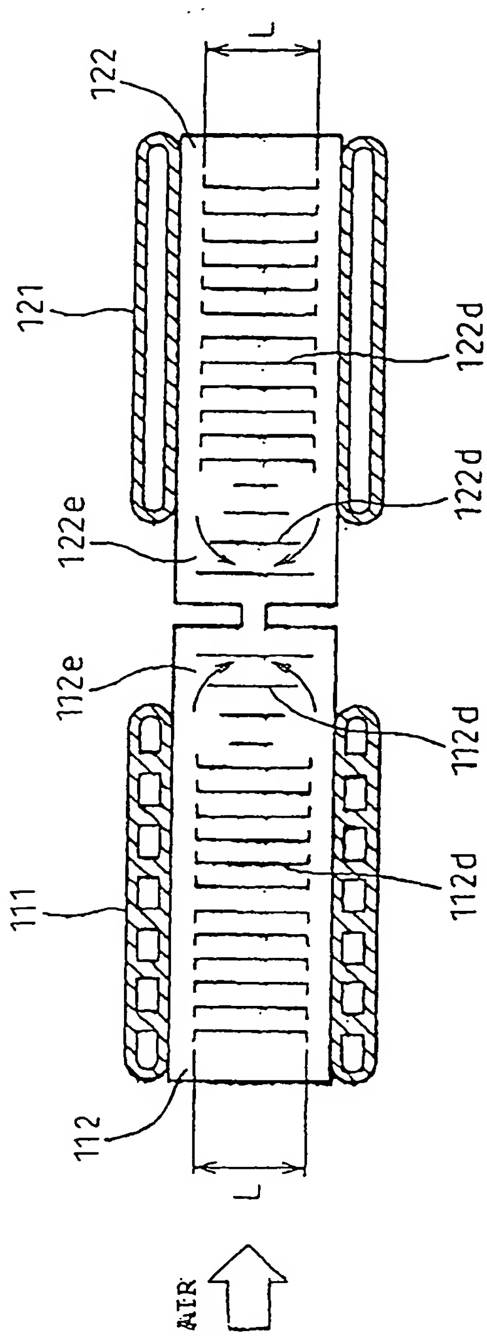
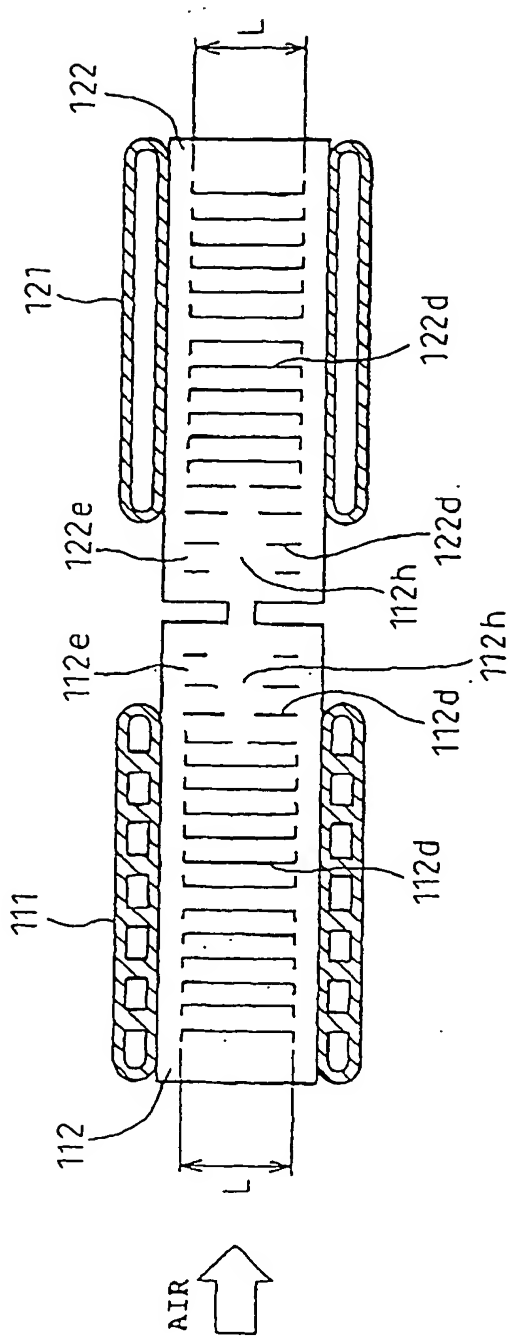


Fig.9



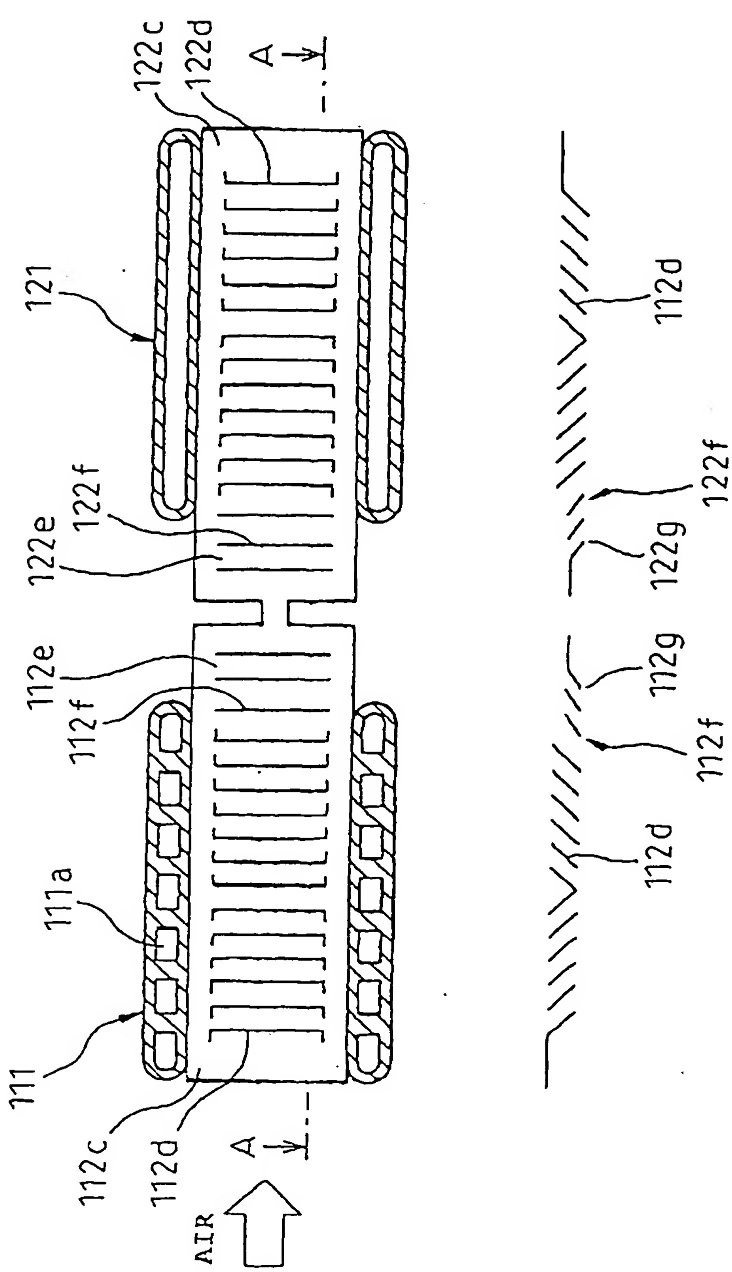


Fig.10A

Fig.10B

Fig.11A

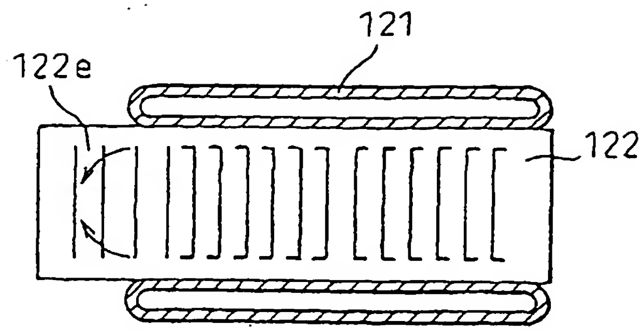


Fig.11B

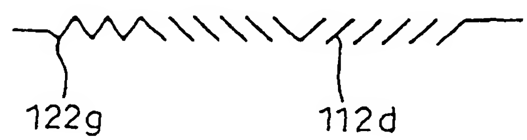


Fig.11C

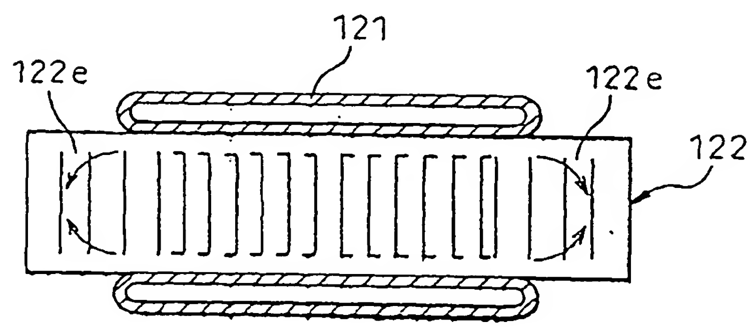
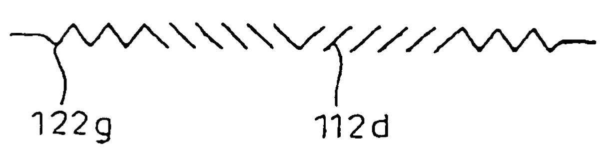


Fig.11D



The reference numerals denote

111 ... Condenser Tube
112 ... Condenser Fin
112e ... Protrusion Portion
112f ... Uneven Portion
121 ... Radiator Tube
122 ... Radiator Fin
122e ... Protrusion portion
122f ... Uneven Portion

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/08827

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^7 F28F1/30, 9/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl^7 F28F1/30, 9/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2001
Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No.108862/1985 (Laid-open No.18583/1987) (Nippon Radiator Co., Ltd.), 04 February, 1987 (04.02.87) (Family: none)	1-3 9-11
X Y	JP, 63-14092, A (Nippon Denso Co., Ltd.), 21 January, 1988 (21.01.88) (Family: none)	1 2,3,9-11
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No.144571/1981 (Laid-open No.52471/1983) (Nippon Radiator Co., Ltd.), 09 April, 1983 (09.04.83) (Family: none)	4,5 6,9-11
X Y	JP, 61-59195, A (Toyo Radiator K.K.), 26 March, 1986 (26.03.86) (Family: none)	4,5 6,9-11
X Y	JP, 6-147785, A (Hitachi, Ltd.), 27 May, 1994 (27.05.94) (Family: none)	4,8 9-11
X	EP, 677716, A1 (Showa Aluminum Corporation),	4,5,9-11

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 March, 2001 (05.03.01)	13 March, 2001 (13.03.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/08827

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	18 October, 1995 (18.10.95) & JP, 7-332890, A & US, 5720341, A	
X	JP, 11-142079, A (ZEXEL CORPORATION), 28 May, 1999 (28.05.99) & WO, 99026035, A & EP, 1030153, A	4,7,9-11
X	JP, 10-9783, A (CALSONIC CORPORATION), 16 January, 1998 (16.01.98) (Family: none)	4,8,9-11
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No.152930/1978 (Laid-open No.73184/1980) (Hitachi, Ltd.), 20 May, 1980 (20.05.80) (Family: none)	6

Form PCT/ISA/210 (continuation of second sheet) (July 1992)